

which as soon as neutral, was filtered and washed with alcohol and ether. An aqueous solution of the salt was neutral towards different indicators. The salt is not deliquescent. It is insoluble in methyl alcohol, ethyl alcohol and ether.

Calc. for $C_4H_4O_6(NH_4)_2$: 15.21%; found: 15.21% N.

Ammonium Itaconate.—Baup¹ states that, like many other ammonium salts, neutral ammonium itaconate does not crystallize since on evaporation or standing in the air it loses ammonia and the acid salt forms.

When ammonia gas is passed into an alcoholic solution of itaconic acid, until a portion of the salt on being dissolved in water shows a neutral solution, there is formed a white, granular, crystalline precipitate of neutral ammonium itaconate. When the ammonia is first passed in, the precipitate formed is slightly gelatinous. The salt was washed with alcohol and ether, and dried for a short time over sulfuric acid in a vacuum desiccator. It is very hygroscopic. In dry air the salt is stable, but loses ammonia in moist air. It is soluble in acetic acid, but insoluble in methyl alcohol, ethyl alcohol and acetone.

The neutral ammonium salt of itaconic acid can also be precipitated in ether as an amorphous compound. The salt prepared in either alcohol or ether readily hydrolyzes when dissolved in water.

Prepared in alcohol: Calc. for $C_5H_4O_4(NH_4)_2$: 17.07%; found: 17.07% N.

Prepared in ether: Found: 17.07% N.

Action of Ammonia on some other Organic Acids.—Attempts to prepare the neutral ammonium salts of isosuccinic, pyrotartaric, aconitic and several other acids have so far given unfavorable results. The precipitates formed were usually very mucilaginous and would not crystallize, even if the ammonia was conducted into the alcoholic or ethereal solution for a long time. Methyl alcohol was tried as a medium in which to precipitate these salts but without success. Work on these acids is being continued. A number of neutral ammonium salts of the higher fatty acids and of the aromatic series have been prepared and analyzed. The results will be given in a future paper. This investigation is being continued with other organic acids.

St. Louis, Mo.

THE DOUBLE AURIC IODIDES OF SUBSTITUTED AMMONIUM BASES.

BY SATYARANJAN DAS GUPTA.

Received February 2, 1914.

The application of the method of double decomposition in the formation of double salts is being systematically studied by Datta and already some interesting results have been obtained by him. Though there are a few

¹ Baup, *Ann.*, 19, 29.

scattered instances of salt formation by the incidental application of this method, yet this has been clearly expounded by him as a principle susceptible of much wide application. He prepared a series of double iodides of platinum and cupric copper by starting with a solution of platinum and cupric chlorides.¹ Later on, he prepared a few more of the double platinum-iodides by precisely the same method.² The double iodides of cadmium and mercury with the substituted ammonium bases have also been prepared by him as an extension of his method.³ The same principle has been applied by him in the preparation of double carbonates of the alkaline earth metals and lead with potassium carbonate, which cannot be prepared by direct means.

These facts induced me to investigate the double auric iodides by the method applied by Datta, *viz.*, the addition of a soluble salt of gold (preferably the chloride) to various substituted ammonium iodides. Now Johnston⁴ prepared several auric iodides with the alkali metals and ammonium by adding auric chloride to the alkali iodide and then allowing the solution which contains the double salt to crystallize. They have also been prepared by him by allowing the solution of auric iodide in alkali iodide to crystallize. Now by the indirect method of Datta the preparation of the double salts with alkali metals has been found to fail, owing to the great solubility of the double salts. The double auric iodide of caesium can, however, be precipitated directly by adding auric chloride to caesium iodide solution, owing to its comparatively small solubility. The double auric iodides of the substituted ammonium bases can be precipitated directly by adding a solution of auric chloride to the solutions of iodides of bases. But the reaction has been found to fail with ethylammonium, diethylammonium, isobutylammonium, allylammonium and anilinium iodides.

The following double iodides have been prepared:

Caesium Auric Iodide, $\text{CsI} \cdot \text{AuI}_3$.—On adding a solution of auric chloride to a solution of caesium iodide, a black precipitate came down which was shaken with the mother liquor for some time. It was filtered and dried in the steam oven. The compound is of a black shining crystalline form.

Analysis: 0.1436 g. gave 0.1603 AgI; I = 60.33%. Calc. for $\text{CsI} \cdot \text{AuI}_3$, 60.69%.

Methylammonium Auric Iodide, $\text{CH}_3\text{H}_2\text{HI} \cdot \text{AuI}_3$.—Methylaminehydroiodide is prepared by adding methylamine to hydriodic acid till the faint brown color is turned colorless. It is evaporated to dryness on the water bath, when a white crystalline powder was obtained. This was dissolved

¹ Datta, *J. Chem. Soc.*, **103**, 426 (1913).

² *THIS JOURNAL*, **35**, 1185 (1913).

³ *Ibid.*, **35**, 949 (1913).

⁴ *Phil. Mag.*, **9**, 266 (1836).

in water to form a moderately strong solution and then a fairly strong solution of auric chloride was added, when a black precipitate was formed, leaving the supernatant liquid dark brown, showing that the salt formed is moderately soluble in water. This was then washed with a small quantity of water on the filter paper and then allowed to dry in a desiccator.

Analysis: 0.1030 g. gave 0.0278 g. Au = 26.83%. 0.0690 g. gave 0.0877 g. AgI; I = 68.70%. Calc. for $\text{CH}_3\text{NH}_2\text{HI}\cdot\text{AuI}_3$: Au = 26.76%; I = 68.90%.

The compound is of a dark black, shining, crystalline form. It changes its color from black to yellowish brown on long standing, proving that the compound decomposes slowly with the formation of aurous iodide and evolution of iodide.

Butylammonium Auric Iodide, $\text{C}_4\text{H}_9\text{NH}_2\text{HI}\cdot\text{AuI}_3$.—A solution of auric chloride is added to a solution of butylamine hydroiodide, when a fine black crystalline precipitate comes down immediately. The solution of auric chloride is added gradually, and during each addition the solution is vigorously agitated. The precipitate is then filtered and washed with a little water. The salt is slightly soluble in water and its solution gives a pale red color.

0.1093 g. gave 0.0298 g. Au, Au = 25.43%; calc. for $\text{C}_4\text{H}_9\text{NH}_2\text{HI}\cdot\text{AuI}_3$; Au = 25.28%.

Dipropylammonium Auric Iodide, $3\text{N}(\text{C}_3\text{H}_7)_2\text{H}_2\text{I}\cdot\text{AuI}_3$.—On adding a strong solution of auric chloride to a solution of dipropylammonium hydroiodide, a tarry, brown, oily, liquid is obtained which suffers no change even on keeping it for some days with the mother liquor. It was then suspected that the double salt itself might be liquid. The mother liquor was decanted off from the oil and the oil was then washed several times with water. The tarry oil was dried and the gold estimated by ignition. The tarry oil on standing in the vacuum desiccator over sulfuric acid for several days, however, solidified to a black, pasty mass.

0.1984 g. gave 0.0308 g. Au; Au = 15.52%; calc. for $3\text{N}(\text{C}_3\text{H}_7)_2\text{H}_2\text{I}\cdot\text{AuI}_3$; Au = 16.10%.

Tripropylammonium Auric Iodide, $4\text{N}(\text{C}_3\text{H}_7)_3\text{HI}\cdot\text{AuI}_3$.—The substance was of a pasty and somewhat liquid consistency and was prepared in exactly the same manner as the dipropylammonium auric iodide. The tarry liquid appeared brown in thin layers.

0.4723 g. gave 0.0584 g. Au; Au = 12.35%; calc. for $4\text{N}(\text{C}_3\text{H}_7)_3\text{HI}\cdot\text{AuI}_3$; Au = 11.85%.

Tetramethylammonium Auric Iodide, $4\text{N}(\text{CH}_3)_4\text{I}\cdot 3\text{AuI}_3$.—This was prepared according to precisely the same method by adding a solution of auric chloride to a moderately dilute solution of tetramethylammonium iodide, when at first a brownish black precipitate is formed, which turns black on shaking. It was washed and dried as usual. The salt is sparingly soluble in water.

0.1006 g. gave 0.0231 g. Au; Au = 22.96%; calc. for $4N(CH_3)_4I_3AuI_3$; Au = 23.38%.

Tetraethylammonium Auric Iodide, $4N(C_2H_5)_4I_3AuI_3$.—To a saturated solution of tetraethylammonium iodide a solution of auric chloride is added drop by drop when a blackish brown precipitate first appears which changes to black on keeping for some time and shaking. It is then filtered, washed and allowed to dry.

0.1257 g. gave 0.0269 g. Au; Au = 21.40%; calc. for $4N(C_2H_5)_4I_3AuI_3$; Au = 21.39%.

Quinolinium Auric Iodide, $2C_9H_7NHI.AuI_3$.—When quinoliniumhydroiodide is dissolved in a moderate quantity of water, a brown, clear solution is formed, but on attempting to dilute it with water it becomes hazy like an emulsion. This may be due to dissociation, on dilution, into quinoline and hydroiodic acid.

To a clear solution obtained in the above manner a dilute solution of auric chloride is added drop by drop with constant shaking. At first a hazy, oily, emulsion of dirty brown color is produced which, on further agitation and addition of auric chloride, becomes crystalline and falls to the bottom, leaving the supernatant liquid only faintly yellow. The compound on filtration appeared of a fine crystalline appearance and is of a black color. The salt is slightly soluble in water to form a pale yellow solution.

0.1558 g. gave 0.0282 g. Au; Au = 18.10%; 0.0992 g. gave 0.1058 g. AgI; I = 57.66%; calculated for $2C_9H_7NHI.AuI_3$; Au = 18.04; I = 58.15%.

Quinolinediethylammonium Auric Iodide, $4C_{11}H_{12}NI_3AuI_3$.—To a saturated solution of quinoline ethyl iodide, a moderately dilute solution of auric chloride is added drop by drop when a black precipitate comes down immediately which was filtered and washed as usual. The salt was perfectly black and was of granular character.

0.1204 g. gave 0.0254 g. Au; Au = 21.09%; calc. for $4C_{11}H_{12}NI_3AuI_3$; Au; Au = 20.56%.

Pyridinium Auric Iodide, $4C_5H_5NHI_3AuI_3$.—To a strong solution of pyridinium hydroiodide, a dilute solution of auric chloride is added, when at first a blackish precipitate is produced which disappears again and produces a haziness but on continual shaking it is gradually transformed into a black precipitate which soon collects at the bottom. The supernatant liquid was colored yellowish brown.

0.1406 g. gave 0.0332 g. Au; Au = 23.54%; calc. for $4C_5H_5NHI_3AuI_3$; Au; Au = 23.07%.

During the preparation of these double salts, vigorous and constant shaking is necessary during each addition of the solution of auric chloride, in order to ensure the completion of the double decomposition—as otherwise secondary products may be formed. Moreover, it had been observed, in some cases, that according to different conditions of carrying

out the preparation different types of salts were obtained. Sometimes a salt of constant composition was not obtained but what was in all probability a mixture of the different types.

I take this opportunity to express my best thanks to Prof. Rây for his encouragement in carrying out the above investigation.

PRESIDENCY COLLEGE, CALCUTTA.

[CONTRIBUTION FROM THE HARRIMAN RESEARCH LABORATORY, ROOSEVELT HOSPITAL, NEW YORK.]

TRICRESOL AS A SUBSTITUTE FOR TOLUENE IN ENZYME WORK.¹

BY SARA S. GRAVES AND PHILIP ADOLPH KOBER.

Received January 12, 1914.

TABLE OF CONTENTS.

1. Introduction. 2. Experimental: Action of tricresol on: (a) Trypsin; (b) Erepsin; (c) Pepsin; (d) Lipase; (e) Urease; (f) Diastase; (g) Invertase. 3. Summary.

1. Introduction.

The results of many enzyme experiments are probably worthless because sterile conditions were not maintained by means of a suitable preservative. To overcome this difficulty before beginning a study of the digestive ferments, it was desirable to find a substitute for toluene, the preservative now in general use.

Toluene has several distinct disadvantages: (1) It evaporates readily, the boiling point being 110° to 112°. (2) It often produces a cloudiness which interferes with optical methods, because of its low solubility in water. (3) It clings to the glass in oily drops, introducing errors in volumetric measurement and necessitating the use of a clean pipet each time. (4) Its bactericidal power is uncertain. The deterioration of a casein solution, after standing at room temperature several months, suggested that toluene does not prevent bacterial action, an idea which has been strengthened by a recent article of Benians on "The Resistance of Various Bacteria to the Disinfecting Action of Toluol and the Allied Bodies, Benzol and Xylol."²

After trying formaldehyde, which, in strong solutions, caused decoloration with proteins and in weak solutions was ineffective, as were sodium chloride and boric acid, a saturated solution of tricresol was found in the laboratory. According to E. J. Banzhaf,³ who suggested the use of tricresol in this connection, the late Dr. A. H. Koelker, while working in this laboratory, had determined that a 0.1% tricresol solution did not interfere

¹ Read before the American Society of Biological Chemists, Philadelphia Meeting, Dec., 1913.

² T. H. C. Benians, *Z. Chemotherap.*, 1, 28 (1913).

³ Private communication.